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SURFACE SENSITIVE V-SHAPED SWITCHING IN CHIRAL SMECTIC LIQUID CRYSTALS

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Antiferroelectricity in chiral smectic liquid crystals shows tristable switching, which is the electric-field-induced transition between antiferroelectric (AF) and ferroelectric (F) phases and has characteristic DC threshold and hysteresis. Although antiferroelectric liquid crystals has some display characteristics superior to ferroelectric liquid crystals, the pretransitional effect in the electric-field-induced AF-F phase transition, which appears as a slight increase in the transmittance below the threshold prevents antiferroelectric liquid crystal displays from achieving much higher contrast. During the development of materials to suppress this pretransitional behaviour, liquid crystalline materials showing thresholdless, hysteresis-free, V-shaped switching have been discovered. This V-shaped switching has attractive display characteristics such as wide viewing angle with high contrast ratio, fast response to applied field etc. suggesting potential for active matrix or thin film addressing in display devices.

This paper presents a study of the influence of the alignment layer coated on the substrate on the V-shaped switching. The liquid crystalline material 4-[(1-trifluoromethyl – 5 - ethoxy) phenyloxycarbonyl – 3 - fluoro] phenyl 4'-(n-undecyloxy) biphenyl – 4 -carboxylate used has the following phase sequence.

Isotropic (82 ^{o}C) Sm A (81 ^{o}C) Sm X*

This material shows V-shaped switching in the phase denoted by Sm X* in thin homogeneous cells. Several polyimides with different chemical structures were used as the alignment layer. In this study, we investigated the influence of the alignment layer on the V-shaped switching by measuring the optical transmittance of the liquid crystal cells made with various alignment layers, under crossed nicols while applying a triangular wave voltage at various frequencies and temperatures. One side rubbed thin homogeneous cells were prepared. The polarization switching current peaks were also observed in the same cells by applying a 1 Hz triangular wave voltage. In order to confirm the surface sensitiveness of V-shaped switching, typical ferroelectric and antiferroelectric liquid crystalline materials were used and carried out similar measurements.

It was found that this V-shaped switching strongly depends on the thickness of the alignment layer coated on the substrate surface. Thick alignment layers give rise to ideal V-shaped switching while thin layers change V-shaped switching to W-shaped switching. Further, it was found that typical ferroelectric and antiferroelectric switching unlike V-shaped switching have essentially no dependence on the thickness of the alignment layer. Very broad switching current peaks were observed for V-shaped switching which is quite different from the shape of the typical switching current peaks of ferroelectric/antiferroelectric liquid crystals. This broad switching current peak would be a characteristic feature of V-shaped switching.